NOTES ON THE FOSSIL CRINOID GENUS HOMOCRINUS HALL.

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The genus *Homocrinus* was defined by Hall in the second volume of the Paleontology of New York. At that time the structure of the type-species, *H. parvus,* was incorrectly given and, furthermore, species representing two other genera were referred to *Homocrinus.* It would appear that the genus *Homocrinus* as there defined by Hall was intended as a sort of "catchall" for practically any Silurian or Ordovician Inadunate. The idea seems to have been to erect a genus comparable in spacious capacity to *Poteriocrinus* and *Cyathocrinus* as they were loosely used at that day. In the third volume of the Paleontology of New York, Hall referred still another species, *scoparius,* to the genus. This species is probably generically distinct from any hitherto called *Homocrinus* by Hall. Under such conditions it is no wonder that the greatest confusion has prevailed in regard to the exact status of the genus. The confusion has not been lessened by the work of subsequent authors, who instead of maintaining the first species described as the type have chosen genotypes from among the other species at one time or another referred to *Homocrinus* by Hall.

As matters stand, we apparently have a choice between no less than three type species. There is the original genotype (first species) *H. parvus; H. scoparius,* which was chosen by Wachsmuth and Springer (1879, p. 77); and, finally, *H. cylindricus,* which was made the type species by Bather (1893, p. 101). It is possible, if not probable, that these three species belong to as many genera. Under the circumstances our conception of the genus *Homocrinus* depends entirely upon the choice of the genotype.

Wachsmuth and Springer in their "Revision," because of the supposed unsatisfactory nature of the two Niagaran species referred to the genus, refused to consider either as the type species, choosing *scoparius* which was described by Hall (1859, p. 102) instead. Bather (1893, p. 101) objects to the choice of *scoparius* as the type-species on the ground that the date of the genus under these circumstances

would have to be altered from 1852 to 1861, "thus predating the name by Eichwald's application of it to *Hoplocrinus dipentas*, a consequence that Wachsmuth and Springer seem to have overlooked." It is to be noted that the other two species referred to *Homocrinus* by Hall in his original description of the genus are ignored by Wachsmuth and Springer when choosing their genotype. These two species are *Poteriocrinus alternatus* Hall and *P. gracilis* Hall, which were described in the first volume of the Paleontology of New York. They have since been referred to the genus *Dendrocrinus* by Wachsmuth and Springer. An examination of Hall's diagnosis of *Homocrinus* makes it evident that the two species cited above were definitely provided for in the new genus. This is clearly shown in the description of the arms, which are stated to be "simple or bifurcating," the arms of *parvus* being simple. If *Homocrinus parvus* and *H. cylindricus* were to be eliminated as unsatisfactory, the other species could not. This would make the genotype of *Homocrinus* an Ordovician Inadunate now referred to the genus *Dendrocrinus*. If the Ordovician species be congeneric with the type species of *Dendrocrinus* this genus must fall into synonymy with *Homocrinus*, as the description of the latter genus precedes the diagnosis of the former in the second volume of the Paleontology of New York.

Bather in choosing *cylindricus* as the type species set aside *parvus*, the first species described by Hall under his new genus, as being based on unsatisfactory material and having been insufficiently described; *cylindricus* and *scoparius* he considers congeneric. As a matter of fact, the structure of *parvus* may be worked out in great detail. *H. cylindricus*, on the contrary, is represented by a not overly well preserved dorsal cup. This does not permit of exact determination, and although its genetic affinities are fairly clear, its use as a genotype is bound to result in uncertainty of generic definition. As regards the accuracy of the original descriptions of the two species there is little choice.

Such a case brings home to us most forcibly the necessity of a definite ruling restricting the powers of subsequent writers in revising the original author's conception of his genus. The question, after all, should be quite as much one of fairness to the original author as one of convenience to subsequent workers. In formulating such a rule it seems to me that paleontologists need not be governed by exactly the same regulations as other zoologists and botanists. In paleontology the type material under normal conditions is indestructible, and in the majority of cases has been preserved. So, too, as a rule, have the descriptions and figures been adequate, and the geological horizons and localities noted with a sufficient degree of accuracy. Generally the original material is to be had if one be willing to spend the time looking for it. If it be not accessible, authentic material is frequently at hand coming from the same locality and horizon. Such being

the case, paleontologists may well be bound by more exact and rigid rules than workers in recent forms. In paleontology no hardship would be wrought, I think, if the first species described were always to be held as the genotype. This ruling, of course, should be effective only in those cases where the original author's choice of a genotype is not specified or indicated. In the very nature of things it is evident that an author, unless giving his species an arbitrary arrangement, tends to place his most characteristic species first. The choice of the first species as genotype is the only wholly satisfactory method of procedure, and obviates much of the confusion that is almost sure to follow the application of any other method. A number of cases might be adduced where the choice of a second type-species by subsequent authors has resulted in an absolute misconception of the true character of a genus.

It seems to me that in no case is the changing of the type-species from the one specified by the author of the genus, or if not definitely specified, the first species described, justified. In case such a species be unrecognizable, and the type material certainly destroyed, the genus should lapse, as in the case of a species under similar conditions. When, as frequently happened in former times, no species was chosen as the type of the genus, it might seem that one should seek the intent of the author, as expressed by his choice of species referred to the genus, and pick out a species other than the first described, for the reason perhaps that better material of that particular form has since become available, or for some other reason. Such reasoning is inadmissible, however. In case a genus were described and the first species is represented by such poor material that its structure could not and can not accurately be determined, the chances are that the other species referred to the genus are not congeneric.

In the present case *Homocrinus parvus*, as the first species defined under the genus, will be held as the type. No excuse is required for this action. This is peculiarly an instance that shows the impropriety of allowing a subsequent writer a voice in the delimitation of a genus by permitting him the choice of the type-species. *Homocrinus parvus* may have been incorrectly defined—as were the types of most of the early genera. The figures and analysis of the cup as given by Hall (1847, pl. 41, figs. 1*c–d*) and partially reproduced in this paper, surely give a present-day worker an inkling as to the true structure of the animal, however. The figure here copied from Hall is fairly accurate. The analysis of the cup is inaccurate in that the brachials are indicated as arising between the radials. A compound radial is unmistakable in both instances, however. Moreover, the types of *Homocrinus parvus* have been at all times accessible in the American Museum of Natural History and a fair amount of authentic

material has always been available. Under such conditions the elimination of *Homocrinus parvus* as type of the genus seems unjustified.

An examination of several specimens of *H. parvus*, including the types, convinced me that the species was a monocyclic Inadunate and bore not the slightest relationship to the forms commonly referred to the genus. In order completely to clear up the matter, it was necessary to have a specimen showing all the plates of the cup. A specimen was kindly placed at my disposal by Mr. Frank Springer, and by the use of specially ground needles and working under a Zeiss binocular the minute theca was finally freed from the matrix. When cleaned and examined in a cell of glycerin the specimen showed all the plates clearly. From this specimen figures 1-4, plate 42, and the analysis of the cup given as figure 8, were made. The outline figure of a crown and portion of column given as figure 5, plate 42, is approximately accurate—as nearly so, perhaps, as a pen-and-ink drawing of this magnification may well be. Exact proportions and details of structure are not to be expected, however. For such particulars and for exact measurements, reference should be made to the text. From these figures it will be seen that the crinoid is a monocyclic Inadunate of a rather unusual type.

A description of the species *Homocrinus parvus*, the only known representative of the genus, may serve equally well as a description of the genus.

The form is minute, the crown of an individual of average size [1] giving a length over all of but 12 mm. In this specimen the height of the dorsal cup is 1.6 mm. Despite their small size the maturity of these crinoids may not be questioned. The specimens show none of the signs of immaturity, either in structure or preservation. Furthermore, the large number of *Homocrinus parvus* that have been found are of essentially the same size, which in itself is strong evidence in support of the assumption that we are dealing with adult forms. Not only must one admit that this material consists of adult specimens, but also that there is no chance of its representing dwarfed individuals. The stratum in which *Homocrinus* is found indicates normal conditions of deposition, while associated fossils show no diminution in size.

The cup is fusiform, slender, and so closely affixed to the tapering column that it is difficult on casual inspection to determine where the theca ends and the column begins. A difference in the clearness of the calcite indicates the line of demarcation with exactness, however. The calcite of the basals is notably more translucent than that of the column. A dorsal cup 1.6 mm. in height has a breadth at the arm bases of 0.95 mm. and a breadth at the junction with the column of 0.65 mm.

[1] The measurements given here and elsewhere of various portions of the crinoid are all taken from one individual.

The basals are five in number, narrow, and unusually long. Their height is a little more than one-half that of the cup, measuring 0.9 mm. in a specimen having a total height of but 1.6 mm.

The radials consist of two simple and three "compound" plates. As usual in such forms, the simple radials are located in the anterior and left posterior rays. The various views of the theca, and the analysis of the cup given in plate 42, clearly show the shape, arrangement, and relative proportions of the plates. The r. post. Rs is hexagonal, resting below on the r. post. Ri and the r. ant. Ri, abutting laterally against l. post. R and r. post. Rs, and supporting on its left shoulder the anal x. r. post. Ri is pentagonal, resting upon the basals, and between r. ant. Ri and l. post. R. It agrees in shape with the l. ant. Ri. r. ant. Rs is quadrangular as is also l. ant. Rs. r. ant. Ri differs from the other inferradials in that it is hexagonal instead of pentagonal, joining as it does with r. post. Rs. The two simple radials are of equal height with each pair of "compound" radials, giving the cup a symmetrical outline. l. post. R supports on its right shoulder the anal x.

Of the anal structures nothing is known other than plate x. This is a small pentagonal plate which rests below equally on the right posterior superradial and the left posterior radial. Laterally it abuts against and is of equal height with the adjacent first primibrachs. It seems probable that x supported a single series of tube plates after the manner of *Ectenocrinus*.

The arms are long, slender, and nonbifurcating. One arm is borne by each ray. There is no evidence of pinnulation. The ventral furrow, as is indicated by a portion of an arm a few millimeters in length, seems to be closed by a double series of alternating covering plates. The first primibrachs are very short and occupy practically the entire breadth of the radial. Measurements in different individuals give a height of 0.35 mm. for this ossicle. The next succeeding brachial and those following up to fully one-half the length of the arms have a practically constant length of 1 mm. In the distal portion of the arms the ossicles tend to shorten very slightly. An ossicle which probably next preceded the terminal has a length of 0.9 mm. The arms are comparatively tenuous, at about one-half the height of the arm the breadth of an articulation being but 0.25 mm. Each ossicle is widest at its extremities, narrowing slightly toward the middle. The shortness of the first primibrachs in cases where the arms are proportionally long or heavy or composed of unusually long ossicles is a feature to be noted in other genera. The first primibrachs of adjoining rays of *Homocrinus* are but slightly separated, and probably when bent inward were in contact laterally.

The column is round. In its proximal portion and for a distance of about 0.6 mm. it tapers rapidly, maintaining the angle of the lower portion of the dorsal cup. Distad from this point the column main-

tains a fairly uniform diameter. At about 5 mm. from the theca the column has a diameter of 0.3 mm. In the sharply narrowing portion of the stem the ossicles are comparatively low and apparently not differentiated into nodals and internodals. In the next millimeter there are alternating wide and narrow ossicles of about the length of those noted above. Distad from this area the columnals are considerably longer and of approximately equal size. From these facts it may be inferred that in adult specimens at any rate increase in the length of the stem by the intercalation of new columnals took place chiefly in that portion of the column lying immediately distad to the proximal group of tapering ossicles. The column attained a length of perhaps five or six times that of the crown. The extreme distal portion of the stem has not been observed.

The geological horizon of *Homocrinus parvus* is at the top of the lower third (lower 17 feet) of the Rochester shale (Niagaran), according to Ringueberg (1888, p. 269). It has only been recorded from Lockport, New York, where it is found associated with characteristic Niagaran fossils.

It is difficult exactly to establish the relationships of *Homocrinus*. On the whole, the affinities of the genus seem to be closest to the Heterocrinidæ, and the genus might well be placed here were it not for its simple, nonbifurcating arms. The simplest type of arm among the Heterocrinidæ is isotomous. It is obviously impossible to derive *Homocrinus* from any known form referred to the family on this account. *Ectenocrinus*, which precedes *Homocrinus* by a considerable period of time, is the form to which *Homocrinus* is most closely comparable structurally. Indeed the arrangement of cup plates in the two genera is essentially identical. The later form, however, has the more simple arms. We may postulate a common ancestor for *Ectenocrinus* and *Homocrinus*. Such a form would probably partake more nearly of the nature of *Homocrinus* than any other known genus. Were the geological positions of the two genera reversed one might well consider *Homocrinus* not far out of the ancestral line which evolved *Ectenocrinus*. We have illustrated here a case of the primitive ancestral type surviving with perhaps few marked modifications long after the extinction of more complex derivatives of the parent stock.

Among the genera of contemporaneous and subsequent geological occurrence *Homocrinus* occupies a somewhat anomalous position. The genus has a similar arm structure to that of the Pisocrinidæ and Haplocrinidæ. The cup has the essential arrangement of plates of *Haplocrinus* as well, with the exception of x reaching down into the cup, as in the Heterocrinidæ. This indicates the presence of an anal tube and a type of tegmen quite at variance with that of *Haplocrinus*. Under the circumstances it has seemed best to establish a new family Homocrinidæ for the reception of the genus. This family may be defined as follows:

HOMOCRINIDÆ, new family.

Monocyclic Inadunata, with 5 B B, 5 R R (3 compound) and an anal x in the cup. The l. post. R and ant. R are large and undivided. In the other three rays the radials are compound. x enters into the composition of the cup, resting equally on the right shoulder of l. post. R and the left shoulder of r. post. R. The presence of an anal tube is predicated. The arms are nonpinnulate and do not bifurcate.

The family as here defined includes but the one genus *Homocrinus*.

Whether *Homocrinus* itself ever gave rise to a line of descendants is a question at present impossible of solution. The Homocrinidæ or forms of very similar structural character might perhaps serve as the ancestral stock for the Pisocrinidæ, Haplocrinidæ, and similar types. A crinoid not widely divergent from *Homocrinus* might, on the other hand, have formed the radicle from which sprung the Heterocrinidæ. Such modifications as are to be observed in these genera are no greater than one might reasonably expect, and indeed the only types from which the Pisocrinidæ and Haplocrinidæ could be derived would partake very largely of the nature of *Homocrinus*. One can but hope that future collections will make it possible to work out in some detail the evolution of this or similar minute forms. With this data in hand the bearing such types have on the evolution of the Crinoidea in general will become more obvious. Until such time our conclusions though apparently logically sound can be but speculative at best.

The existence of such a form as *Homocrinus parvus* causes one to wonder if during Paleozoic time, and perhaps later, there did not live many equally minute crinoids. We know in the Mississippian for example, that there was a species of *Allagecrinus* quite as small as *Homocrinus parvus*. Such types were not derived from crinoids larger than themselves. In the development of any group of invertebrates the trend of evolution is from the small to the large, and never the reverse except in special cases of degeneracy or dwarfing. *Homocrinus* though showing no positive tendencies in any direction, owing to our lack of knowledge relative to its ancestors or descendants, certainly shows no signs of degeneracy. The improbability of its having been dwarfed has been noted elsewhere. Such being the case we may postulate for *Homocrinus* ancestors of similar size or even smaller.

If we assume the existence of such a practically unknown congeries of microscopic crinoids, as we well may be justified in doing, it seems possible that these small types at various times may have furnished points of inception for evolutionary lines among the Crinoidea. Certain it is that the maintenance of such a basic stock would serve to explain the presence of many otherwise anomalous forms in our Paleozoic rocks. Many of our Inadunata might be cited as examples. Some of these types appear quite suddenly, and though frequently

of wide geographic range and of notable strength numerically, are without known antecedents. As an instance of this sort, we have *Haplocrinus*, a form curiously primitive in many respects despite its Middle Devonian occurrence. This genus has a known range from Germany to New York State. As elsewhere suggested, this genus may well have been derived from a form not greatly dissimilar to *Homocrinus*. One or two such cases of apparently isolated types might be explained on the assumption of sudden introduction into a given area of hitherto excluded faunas. To attempt to explain all such cases and the related phenomena on such a basis would involve an unnecessary assumption of unstable seas and barriers.

The importance of such a simple group in determining or influencing the evolution of the Crinoidea is largely dependent upon the ability of its constituent members under the impetus of changed conditions or for other cause, to vary and give rise to sturdy lines in which the tendency toward mutation is perpetuated. One must predicate such power as latent in these minute forms, else their interest and importance lies solely in their existence. As is well known, a type that persists for a long time apparently loses its power to vary, at least fundamentally. So it is in the case of many long-lived brachiopods. Such instances are those preeminently of genera and species. It probably is true that in larger groups much the same condition of affairs obtains, though in a less marked degree. With them the tendency toward variation is arrested rather than destroyed, however, and though somewhat impaired in vigor may be revived by the application of competent stimuli. Subsequent to such stimulation it may well be that the resultant lines do not have the inherent strength of those evolved earlier in the history of the stock, but such differences tend to be quantitative rather than qualitative. Such limitations necessarily apply only to the minute primitive forms of the later Paleozoic. The status of such forms in the early history of the Pelmatozoa is probably quite different. Here there existed anything but a condition of stagnation. In their small way mutations doubtless were of frequent occurrence and of appreciable weight.

How very acceptable such an hypothesis will prove may readily be seen. Given a persistent stock of primitive character and one may predicate offshoots in the evolution of which convergence and parallelism will generate types strikingly similar in many respects and yet incapable of derivation one from the other. That conditions exist among the Crinoidea explicable only on the assumption of the existence of numerous polyphyletic strains seem capable of demonstration. Indeed it is probable that few of the groups into which the Crinoidea have been subdivided are monophyletic—unless such groups be comparatively small and closely circumscribed.

The existence of a potent primitive stock among the Crinoidea is of large importance as determining evolution within that group. If we extend our horizon the bearing of such a stock on the Pelmatozoa as a whole presents features of even greater consequence. The interrelationships of the classes of the Pelmatozoa have always been a matter of no little uncertainty—even to the extent of establishing plausible connections between the classes. The solution of the matter lies, I think, in the acceptance of a minute stock in which fundamental modifications may well have taken place and from which the various classes diverged more or less independently. There is no reasonable objection to such an hypothesis and it has much of the available evidence in its favor.

It has generally been conceded that the Crinoidea have been derived from the Cystidea, perhaps through the mediation of the Blastoidea. Such may be the case—but not from the Cystidea or Blastoidea as we know them. As we trace back any given crinoid line, at least in that portion of the line antecedent to the acme of the group, we find a uniform decrease in the size of the organisms. Eventually we come to the small simple Inadunata. To evolve these simple forms from the Cystidea as we know them is a contravention of the fundamental laws of evolution. If we admit these facts we must look elsewhere than among the known Cystidea for the ancestors of the Crinoidea. The ancestors no doubt may have had much the same structure as the Cystidea and evolved their comparatively simple arrangement of plates by much the same process that we may more or less readily trace in the elimination of plates among the Cystidea. The whole evolution, however, was on an infinitesimal scale. Did such types exist, as seems to be the logical conclusion, one could style them perhaps "Cystidea", as that term might broadly be defined. That there should be minute Cystidea is no more improbable than that there should be minute Crinoidea—which we know exist. Such minute "Cystidea" might well precede and give rise to the known Cystidea, as well as to the other classes of the Pelmatozoa.

Having shown *Homocrinus* to be a monocyclic Inadunate of quite different affinities than has hitherto been supposed, it becomes necessary to define a new genus for the reception of such forms as "*H.*" *scoparius*. For this genus I here propose the name *Lasiocrinus*, taking *scoparius* as the type of the genus. For the time being but two species will be referred to the genus, *scoparius* and *tenuis*. The systematic position of the other species called *Homocrinus* by Bather (1893, p. 101) is doubtful. I have examined the types of *ancilla* and *cylindrica* and at present feel disinclined to include them in the same genus with *scoparius*. In a future more extended discussion

of *Lasiocrinus* the possible affinities of the forms hitherto called *Homocrinus* will be treated at length. Inasmuch as this genus is composed of forms that are so well known, and the characters upon which it is founded are those upon which the genus "*Homocrinus*" has hitherto been maintained, it is scarcely necessary to describe the genus in any considerable detail.

LASIOCRINUS, new genus.

1852. ? *Homocrinus* Hall part, Paleontology of New York, vol. 2, p. 185.
1859. *Homocrinus* Hall, Paleontology of New York, vol. 3, p. 102.
1879 and 1886. *Homocrinus* Hall part, Wachsmuth and Springer, Revision of the Palæocrinoidea (Author's Edition), pt. 1, p. 77; pt. 3, p. 220.
1893. *Homocrinus* Hall part, Bather, Crinoidea of Gotland, p. 101.

I B B 5, pentagonal, equal. B B 5, hexagonal, with the exception of post. B and r. post. B which are heptagonal. R R relatively small with the arm facets occupying practically the entire width of the upper faces of the plates. R A rhomboidal, small, resting below on the left shoulder of r. post. B and the right shoulder of post. B. Above it supports x and r. post. R. Anal x rests below on post. B and R A. Laterally it meets l. and r. post. R R, and above it supports two plates of the anal tube. The anal tube is long and after a point a short distance above its base is composed of a somewhat variable number of parallel rows of small hexagonal plates. The arms are long and in the type species divide by bilateral heterotomy at regular intervals. The arms of earlier species are apparently dichotomous, as might be expected. The column is round. In plate 42, figures 10–12 are given to show the essential features of the type species *Lasiocrinus scoparius*. Figure 10 gives an excellent idea of the structure of the ventral sac, and figure 11 shows the method of division of the arms and general proportions of the crown. Figure 12 is an analysis of the dorsal cup. The figure of *Lasiocrinus tenuis* (fig. 9) is given to show the structure of the earlier, Silurian member of the genus.

Lasiocrinus has a vertical range from the Silurian of Gotland apparently to the Onondaga of New York. Besides the species already noted there are new species probably referable to this genus in the Manlius, New Scotland, Oriskany, Schoharie, and Onondaga formations. The genus is characteristically a Devonian one, with the exception of the Manlius and the Gotland Silurian forms.

Type of the genus.—Homocrinus scoparius Hall.

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1879. WACHSMUTH and SPRINGER. Revision of the Palæocrinoidea: Pt. 1, Proc. Acad. Nat. Sci. Philadelphia for 1879, pp. 226–378, pls. 15–17. Author's edition, 153 pp. pls. 1–3.

1886. ——— Revision of the Palæocrinoidea: Pt. 3, sec. 2, Proc. Acad. Nat. Sci. Philadelphia for 1886, pp. 64–226. Author's edition, pp. 139–334.

EXPLANATION OF PLATE 42.

Homocrinus parvus Hall.

Fig. 1. View of left anterior radius of dorsal cup, and first primibrachs. × 8.
2. View of posterior interradius. × 8.
3. View of right posterior interradius. × 8.
4. View of anterior radius. × 8.
5. View of another specimen showing crown and portion of column. × 3.
6. View apparently of left anterior radius × 3? after Hall, Pal. New York, vol. 2, pl. 41, fig. 1*c*.
7. Analysis of dorsal cup, copied from Hall, Pal. New York, vol. 2, pl. 41, fig. 1*d*.
8. Analysis of the dorsal cup. × 8.

Lasiocrinus tenuis (Bather) new combination.

Fig. 9. Posterior interradius × 3, after Bather, Crinoidea of Gotland, pl. 4, fig. 144.

Lasiocrinus scoparius (Hall) new combination.

Fig. 10. Posterior interradius of one of the type specimens. × 2.
11. View of crown × 2, probably of anterior radius.
12. Analysis of dorsal cup. × 4.